Ilmu Pertanian (Agricultural Science)

http://journal.ugm.ac.id/jip

Vol. 7 No. 1 April, 2022: 19–24| DOI: doi.org/10.22146/ipas.65548

Augmented analysis for yield performance and agronomic characteristics of upland rice lines grown under coconut plantation

Angelita Puji Lestari*, Aris Hairmansis, Rini Hermanasari, Yullianida, and Suwarno

Indonesian Center for Rice Research
Jln. Raya 9, Sukamandi, Subang, West Java 41256, Indonesia
*Corresponding author: angelitapujilestari@gmail.com

Article Info

Received : 28th April 2021
Revised : 31st August 2021
Accepted: 13th December 2021

Keywords:
Observation, promising lines, shade tolerant, upland rice

Abstract

Establishment of shade-tolerant rice varieties aims to utilize the dry land under tree stands. A field experiment on rice yield under coconut plantation was conducted at farmer field in Calincing Tegalbuleud Sukabumi, West Java, Indonesia. The experiment involved 307 upland promising lines, 42 of which were selected in comparison to four check varieties, namely Jatiluhur, Batutugi, Limboto and Situpatenggang. The experiment was conducted according to augmented design with four replications. The analysis of variance indicated significant difference in yield per ha between blocks and no significant differences in days to flowering, plant height and number of productive tiller between blocks. Meanwhile, significant differences were observed in plant height and number of productive tillers between all check varieties. Under shade of coconut plantation, some lines could perform better and had higher performance than check varieties. Four lines ofB11957-SR*-2-3-2-18-2-SI-2-MR-2-PN-2-1, B12743-MR-18-2-3-2-PN-1-1-1-1, B13498D-9, and B12743-MR-18-2-3-5-PN-10-3-1 had significantly higher yield compared to the check variety with the highest yield, which is Limboto. The utperforming lines can be proposed as promising rice lines for shading tolerance. However, most of the lines were proved to be underperforming for yield and its components in prevailing conditions.

INTRODUCTION

The most important constraint in land under plantation and forestry is the low intensity of mild due to coloration, in addition to excessive soil acidity and drought threats (Sopandie and Trikoesoemaningtyas, 2011). The capacity of plants to cope with shade stress depends on their capacity to conduct photosynthesis under light deficit conditions. Improvement of yield potential and plant adaptation to biotic and abiotic stresses is an effort to increase production on marginal land, including under plant standing (Sopandie, 2006).

One of the efforts in improving the efficiency and productivity of agricultural land can be done through the concept of intercropping system, which is by planting on dry land under plantation stands in the time of unproduced plants (TBM). If this condition can be optimized, crop production can be improved (Barus 2013). However, the percentage of irradiation and soil fertility still become the problems (Wijaya et al., 2015).

Shading significantly affects the depth of light received by rice plants. The lack of light causes the plants to experience etiolation. According to Susanto and Sundari (2011), plants experiencing shading stress generally tend to have fewer branches than those without shade. Changes in plant height (etiolation) were seen in plants under shade greater than 25 %. This is due to the excessive manufacturing and distribution of auxin, which stimulates the elongation of cells, thereby promoting the increased plant height.

How to cite: Lestari, A.P., Hairmansis, A., Hermanasari, R., Yullianida, and Suwarno. (2022). Augmented analysis for yield performance and agronomic characteristics of upland rice lines grown under coconut plantation. *Ilmu Pertanian (Agricultural Science)*, 7(1), pp. 19–24.

ISSN 0126-4214 (print) ISSN 2527-7162 (online)

The Indonesian Center for Rice Research has worked for creating upland rice varieties that may be tolerant to shade. This effort started from hundreds hybridization since the year of 2011. After couple of years, two promising lines of B12056F-TB-1-29-1 and B12480D-MR-7-1-1 were approved for release as new improved varieties of shade-tolerant rice under the name of Rindang 1 and Rindang 2, respectively, in December 2016.

One of the agricultural field experimental designs is augmented design proposed by Petersen in 1994, followed by Saleem et al. (2013). There is a set of check entries, which can be replicated with the same number in a specified field design, and a set of new check entries is included in the experiment only once (Saleem et al., 2013). Any form of block design can be used for the check correction with the check entries being added or 'augmented' to the blocks, and the standard error for the difference between check entries might also additionally simply be calculated. The rice lines outperforming the suggested performance of the check varieties least significant increase (LSI) can be rated as significantly better than of the recommended check varieties (Sutaryo, 2014). This research design is utilized by breeder for selecting parental genotypes for hybridization (Wijaya et al., 2015).

MATERIALS AND METHODS

A field experiment on rice yield was The experiment involved 307 rice lines, 42 lines of which were selected and listed in Table 1. Seeds were spread directly with a spacing of 30 cm × 15 cm in plot size 2 m × 5 m. The fertilizer used were 300 kg.ha^{-1} Phonska and 100 kg.ha^{-1} urea. The experiment was arranged in augmented design with four check varieties, consisiting of Jatiluhur, Batutugi, Limboto and Situpatenggang, and four

Table 1. Codes of the selected rice lines and check varieties used in this study

No	Line/variety	No	Line/variety
2	B14981B-TGB-7-1	229	B13131-7-MR-1-KA-1-4-B-TGB-12
4	B14981B-TGB-7-3	243	B13132-8-MR-1-KA-21-B-TGB-39
5	B14981B-TGB-9-1	257	B13132-8-MR-2-KA-9-B-TGB-11
6	B14981B-TGB-9-2	262	B13132-8-MR-2-KA-9-B-TGB-24
7	B14981B-TGB-9-3	286	B13134-4-MR-1-KA-1-B-TGB-40
13	B14981B-TGB-20-3	287	B13134-4-MR-1-KA-1-B-TGB-42
14	B14981B-TGB-27-1	288	B13654-2E-WN-2
15	B14981B-TGB-27-2	290	B11787E-MR-2-9-7
36	B14981B-TGB-41-1	292	B12495C-MR-69-1-9
38	B14981B-TGB-41-3	293	B12160D-MR-11-3-4
89	B15033B-TGB-31-3	296	B13498D-9
97	B15033B-TGB-47-2	297	B13017B-RS*1-2-5-PN-2-2-3
123	B15033B-TGB-79-2	298	B13017B-RS*1-2-6-PN-10-5-5
124	B15033B-TGB-79-3	299	B13017B-RS*1-2-6-PN-11-2-1
168	B13134-4-MR-1-KA-1-B-TGB-35-3	302	B11957-SR*-2-3-2-18-2-SI-2-MR-2-PN-2-1
170	B13134-4-MR-1-KA-1-B-TGB-36-2	303	B11957-SR*-2-3-2-18-2-SI-2-MR-2-PN-3-3
205	B14981B-TGB-5	304	B12743-MR-18-2-3-2-PN-1-1-1-1
207	B14981B-TGB-47	305	B12743-MR-18-2-3-5-PN-10-3-1
208	B14981B-TGB-50	306	B12743-MR-18-2-3-7-PN-11-3-1-1
216	B13144-1-MR-2-KA-3-1-B-TGB-17	Check 1	Jatiluhur
219	B13144-1-MR-2-KA-3-1-B-TGB-40	Check 2	Batutugi
222	B13131-7-MR-1-KA-1-4-B-TGB-1	Check 3	Limboto
227	B13131-7-MR-1-KA-1-4-B-TGB-10	Check 4	Situpatenggang

replications. This experimental design was used by Dilnesaw et al. (2013).

The data recorded include days to flowering, plant height, and number of productive tillers. To estimate the experimental error, the standard evaluation of variance for a randomized block design was completed with the aid of the facts of checks. Variations and their standard errors were analyzed following augmented design techniques by Saleem et al. (2013) as follows:

1. Differences between means of two check varieties:

$$\text{standard error, Sc} = \sqrt{\frac{2MSE}{r}}$$

2. Differences between adjusted yields of two new selections in the same block:

$$\text{standard error, Sd} = \sqrt{2MSE}$$

3. Differences between adjusted yields of two new selections in different blocks:

$$\text{standard error, Sv} = \sqrt{\frac{2(c+1)MSE}{c}}$$

4. Differences between adjusted yield of a new selection and a check mean:

$$\text{standard error, Svc} = \sqrt{\frac{(r+1)(c+1)MSE}{rc}}$$

Those standard errors are used tocalculate LSI values.

RESULTS AND DISCUSSION

The mean squares for analysis of variance of check varieties had been confirmed in Table 2. The analysis of variance indicated significant differences in yield between blocks for as well as in plant height and the number of productive tillers between check varieties. It confirmed that there was variability between check varieties for those characteristics. However, there was no significant difference in days to flowering between blocks and check varieties. The estimates of standard errors of four different comparisons to calculate least significant increase (LSI) are presented in Table 3. The plantation in this experiment is shown in Figure 1.

The adjusted characteristics of the check varieties and selected rice lines for new alternatives are given in Table 4. The maximum beneficial contrast might be between the adjusted values of the selected rice lines and those of the check varieties. This test used LSI to discover the selected rice lines that outyielded the check varieties. The values of the adjusted characteristics of the selected lines that are higher than the standard overall performances (observed mean + LSI) helped obtain a various comparisons for each check variety new selected lines.

The yield of the 42 rice lines selected ranged from 1.54 $ton.ha^{-1}$ to 5.50 $ton.ha^{-1}$ (Table 4). Four new selected lines, including lines 302, 304, 296, and 305 or B11957-SR*-2-3-2-18-2-SI-2-MR-2-PN-

Figure 1. Experimental field under coconut tree plantation, Tegalbuleud Sukabumi.

Table 2. Mean square for analysis of variance of the check varieties

Source	df	Yield ($ton.ha^{-1}$)	Days to flowering	Plant height	Number of productive tiller
Total	15				
Blocks	3	4.37**	6.08	213.54	0.84
Checks	3	0.09	14.08	275.05*	10.76*
Error	9	0.45	39.03	69.13	2.69

Remarks: *,** = Significant at 0.05 and 0.01 level of probability, respectively

Table 3. Standard errors (SE) for various comparisons

Differences	Yield ($ton.ha^{-1}$)	Days to flowering	Plant height	Number of productive tiller
Difference between means of check varieties (Sc)	0.47	4.42	5.88	1.16
Difference between adjusted means of two selections in the same block (Sb)	0.95	8.83	11.76	2.32
Difference between adjusted means of two selections in different blocks (Sv)	1.06	9.88	13.15	2.60
Difference between adjusted means of a selection and a check (Svc)	0.84	7.81	10.39	2.05
LSI=tα.Svc	1.53	14.31	19.05	3.76

2-1, B12743-MR-18-2-3-2-PN-1-1-1-1, B13498D-9, and B12743-MR-18-2-3-5-PN-10-3-1 (Table 1), respectively, had significantly higher yield than that of the check variety with the highest yield, which is Limboto. Wang et al. (2015) confirmed that the intensity of irradiation (shade) had a large impact on the plant height, the number of tillers, the number of productive tillers, the number of filled grains, the grain weight per plot, and the grain weight per ha. This finding is also in line with Ginting et al. (2015). Liu et al. (2009) found out that rice flowers grown under low light from the transplanting to the booting stages showed a 34.51 % reduction in grain yield partially caused by a tremendous lower withinside the numbers of fertile panicles and grains per panicle produced. Li et al. (2010) also found that when rice plants were exposed to to low humidity for 10 days from the heading stage, the grain yield decreased by 14.99 % due to the decreased seed-setting rate was.

All selected lines showed significantly shorter days to flowering than the check variety with the shortest days to flowering, which is Limboto (108.3 days), starting from 83.4 days to 105.4 days. A wider variety of productive tillers is the main yield component in rice. Sixteen new selections had a significantly wider variety of productive compared to Situpatenggang. The low humidity causes poor production of tillers, impaired capacity of panicle differentiation, and unusual grain-filling conditions (Li et al., 2010). Liu et al. (2006) and Goto and Kumagai (2009) also found out that low light depth at the vegetative stage particularly decreased not only the number of productive panicles per unit area but also the grain size and appearance, milling and consuming qualities, and general sugar content (Ginting et al., 2015; Wang et al., 2015).

CONCLUSIONS

This research shows that augmented design is useful for analyzing the yield or component yield of the potential ricelines. Under the shade of coconut plantation, there were some lines that could perform better and had higher performance than the check varieties. Four lines, including B11957-SR*-2-3-2-18-2-SI-2-MR-2-PN-2-1, B12743-MR-18-2-3-2-PN-1-1-1-1, B13498D-9, and B12743-MR-18-2-3-5-PN-10-3-1 had significantly higher yields than that of check variety with the highest yield, which is Limboto. The outperforming lines can be proposed as promising shading-tolerant rice lines.

Table 4. Adjusted characteristic performance of the selected rice lines and check varieties

Selected line no	Yield (ton.ha^{-1})	Selected line No	DF	Selected line no	PH (cm)	Selected line no	NPT
302	5.50	4	83.4	243	82.4	296	26.31
304	5.50	2	84.4	293	87.1	302	24.98
296	5.46	5	84.4	297	91.4	306	22.31
305	4.73	7	87.4	303	93.8	305	20.65
297	4.28	13	87.4	296	93.8	299	19.65
298	4.23	6	87.4	299	95.1	286	18.65
2	4.05	262	89.4	287	95.8	298	18.31
124	3.89	288	91.4	216	96.4	262	18.31
299	3.80	290	91.4	298	96.4	304	17.98
123	3.79	14	93.4	304	96.8	297	16.98
303	3.77	15	93.4	229	98.4	303	15.98
288	3.75	124	94.6	222	99.4	290	15.65
290	3.74	123	94.6	219	100.0	293	14.98
306	3.72	89	94.6	286	101.4	243	14.65
4	3.72	205	94.6	306	102.1	292	14.31
7	3.49	207	94.6	227	105.4	288	13.65
14	3.35	208	94.6	13	105.4	287	12.31
13	3.24	97	94.6	302	105.4	89	8.20
262	3.20	302	95.4	257	105.4	227	7.78
292	3.19	304	95.4	305	107.4	257	7.35
216	3.15	305	95.4	38	107.4	123	7.20
287	3.15	303	95.4	123	109.4	124	6.20
222	3.08	292	95.4	290	113.8	222	5.78
38	2.93	38	95.4	36	114.4	38	5.37
89	2.93	293	95.4	14	114.8	13	5.03
293	2.92	36	95.4	124	114.8	2	5.03
205	2.88	296	97.4	5	117.8	15	5.03
207	2.85	297	97.4	208	119.7	170	4.78
208	2.84	298	97.4	89	120.8	4	4.70
168	2.82	299	97.4	207	122.7	97	4.53
15	2.68	306	97.4	7	124.1	205	4.12
229	2.58	168	100.6	6	124.1	219	3.78
219	2.50	216	102.6	292	125.1	36	3.70
97	2.35	222	102.6	288	127.8	14	3.70
227	2.17	229	102.6	97	130.8	7	3.70
6	2.16	219	102.6	168	133.0	6	3.70
286	2.13	227	102.6	170	133.0	216	2.78
243	2.08	287	103.4	4	134.8	168	2.78
257	2.05	286	103.4	205	141.0	229	2.12
5	1.84	257	103.4	2	151.8	5	2.03
170	1.59	170	105.6	262	158.1	208	1.78
36	1.54	243	106.4	15	158.1	207	1.45
Check 1	2.55	Check 1	94.3	Check 1	126.6	Check 1	7.00
Check 2	2.68	Check 2	98.0	Check 2	126.6	Check 2	5.42
Check 3	2.91	Check 3	94.0	Check 3	109.3	Check 3	5.67
Check 4	2.62	Check 4	96.3	Check 4	124.1	Check 4	9.00
Mean + LSI		**Mean + LSI**		**Mean + LSI**		**Mean + LSI**	
Check 1	4.08	Check 1	108.6	Check 1	145.6	Check 1	10.76
Check 2	4.22	Check 2	112.3	Check 2	145.6	Check 2	9.18
Check 3	4.44	Check 3	108.3	Check 3	128.4	Check 3	9.43
Check 4	4.16	Check 4	110.6	Check 4	143.1	Check 4	12.76

ACKNOWLEDGMENTS

We would like to present our gratitude to Mr. Supartopo, our technician Djajuli, Oma, Warsono, and Sukirman for their hard work during this experiment and data recording.

REFERENCES

Barus, J. (2013). Pemanfaatan lahan di bawah tegakan kelapa di Lampung. *Jurnal Lahan Suboptimal,* 2(1), pp. 68–74.

Dilnesaw, Z., Abadi, S., and Getahun, A. (2013). Genetic variability and heritability of soybean (*Glycine max* (L.) Merrill) genotypes in Pawe district, Metekel zone, Benishangule Gumuz regional state, Northwestern Ethiopia. *Wudpecker Journal of Agricultural Research*, 2(9), pp. 68–74.

Ginting, J., Damanik, B. S. J., Sitanggang, J. M., and Muluk, C. (2015). Effect of shade, organic materials and varieties on growth and production of upland rice. *International Journal of Scientific & Technology Research*, 4(1), pp. 68–74.

Goto, E. and Kumagai, S. (2009). The effect of temperature and shading on notched-belly rice kernel in Hokkaido rice variety 'Nanatsuboshi'. *Japan Intenational Crop Science*, 78(1), pp. 35–42.

Li, H.W., Jiang, D., Wollenweber, B., Dai, T.B., and Cao, W.X. (2010). Effects of shading on morphology, physiology and grain yield of winter wheat. *European Journal of Agronomy*, 33, pp. 267–275.

Liu, Q. H., Li, T., and Zhang, J. J. (2006). Effect of shading at the early stage on the growth of function leaves at the grain filling stage and quality in rice. *Chinese Journal of Ecology*, 20(10), pp. 1167–1172.

Liu, Q. H., Zhou, X. B., Yang, L. Q., Li, T., and Zhang, J. J. (2009). Effects of early growth stage shading on rice flag leaf physiological characters and grain growth at grain-filling stage. *Chinese Journal of Applied Ecology*, 20(9), pp. 2135–2141.

Saleem, M. Y., Asghar, M., and Iqbal, Q. (2013). Augmented analysis for yield and some yield components in tomato (*Lycopersicon esculentum* Mill.). *Pakistan Journal of Botany*, 45(1), pp. 215–218.

Sopandie, D. (2006). Perspektif fisiologi dalam pengembangan tanaman pangan di lahan marjinal. Orasi Ilmiah Guru Besar, Institut Pertanian Bogor, 16 September 2006, pp. 100.

Sopandie, D. and Trikoesoemaningtyas. (2011). Pengembangan tanaman sela di bawah tegakan tanaman tahunan. *Iptek Tanaman Pangan*, 6(2), pp. 168–182.

Susanto, G. W. A. and Sundari, T. (2011). Perubahan karakter agronomi aksesi plasma nutfah kedelai di lingkungan ternaungi. *Jurnal Agronomi Indonesia*, 39(1), pp. 1–6.

Sutaryo, B. (2013). Penampilan agro-morfologi dan parameter genetik 12 genotip padi di sawah berpengairan teknis. *Ilmu Pertanian (Agricultural Science)*, 17(1), pp. 13–24.

Wang, L., Deng, F., and Ren, W.J. (2015). Shading tolerance in rice is related to better light harvesting and use efficiency and grain filling rate during grain filling period. *Field Crop Research*, 180, pp. 54–62.

Wang, L., Deng, F., Ren, W.J., and Yang, W.Y. (2013). Effects of shading on starch pasting characteristics of indica hybrid rice (*Oryza sativa* L.). PLoS ONE. 8e68220.

Wijaya, A. A., Rahayu, H.D., Oksifa, A. R. H., Rachmadi, M., and Karuniawan, A. (2015). Penampilan karakter agronomi 16 genotip kedelai (*Glycine max* l. Merrill) pada pertanaman tumpangsari dengan jagung (*Zea mays* L.) pola 3:1. *Jurnal Agro*, 2(2), pp. 30–40.